Tephra Glass Trace Element Database

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1. Introduction

Ash fallout (tephra) is used with uranium-lead dating of zircon crystals to approximate the timing of sedimentary deposition in cases where no discrete volcanic ash beds are present. Being able to identify ages of specific tephra layers allows geologists to map the distance from their volcanic source, estimate the geographic extent of fallout, and refine the timing of related tephra deposits. These age constraints also provide valuable chronological control for reconstructing regional tectonic events, climatic changes, and biological records preserved within associated sediments. In this way, tephra not only serves as a marker horizon within stratigraphy but also as a tool for linking local sedimentary sequences to broader volcanic and environmental histories.

The Grubstake tephra is a ~12 m thick rhyolitic ash bed in the Alaska Range, dated at 6.83 ± 0.11 Ma by 40Ar/39Ar methods. Geochemical evidence links it to Aleutian Arc volcanism during the late Miocene, a period of significant tectonic and geomorphic change in the region. It lies within the Grubstake Formation, the uppermost unit of the Usibelli Group, which consists mainly of lacustrine deposits interbedded with volcanic horizons. The overlying Nenana Gravel records nearly 1200 m of foreland basin sedimentation, interpreted as a response to rapid unroofing of the Alaska Range beginning around this time.

Taking readings from tephra can create mountains of unorganized data and unintelligible data to people who aren't specialized in the field. . To address this issue we would need to create a better way of storing data that can (i) Create a user-friendly graphical user interface (GUI) for ease of use (ii) Load faster with a greater amount of data (iii) Keep it organized and easily shareable with others around the world (iv) Be able to convert past semi-organized data into the newer format for easier integration.

2. Literature Review

Zircon geochronology, specifically U-Pb dating of volcanic zircon has become a widely used method of dating sedimentary basins. Early studies (e.g., Gebauer et al. 1989; Bitshene and Schmincke, 1990) demonstrated the value of zircons in sedimentary layering where other dating tools would have been unavailable. More recent work has applied this approach to reconstruct tectonic and erosional history within Alaska and the Yukon as well as paleoclimate changes tied to tephra and the correlations of widespread volcanic horizons across continents. These studies highlight the versatility of zircon dating around the world.

Despite these advances significant gaps remain. Most detrital zircon studies rely on sand sized grains yet volcanogenic zircons are often finer and are easily lost in mineral separation. This leads to an under representation of syn-depositional zircons in sedimentary records. Adhered volcanic glass coatings can be destroyed during preparation, making identification of eruption based zircons yield few to none recognizable volcanic zircons.

The mismatch between known volcanic activity and the absence of syn-depositional zircon signals highlights in the need for better recovery techniques as well as better data handling as a lot of data is either unreadable or unorganized and thus lost.

3. Methods

Currently this research project would be focused on handling data and preserving it properly in a way that is easy to read and more efficient to store by cutting load times. The data that will be used for testing how well the developed software will work will be Grubstake Tephra data as it will be newly collected and will show the strengths of the program in development. The program will allow for storing the data in database files rather that excel spreadsheets which will cut load times and search times for the data itself. Since this will be using SQL it would be appropriate to allow users to also use their own SQL queries so they can find exactly what they are looking for, this would require some technical knowledge but is completely optional for the average user.

The program should also include a way to convert older datasets into this new format as to allow for an easy transition into using the software. Development will mainly consist of python programming and using tkinter to design a proper graphical user interface. Backend of the program as iterated previously will be using SQL which allows for data to be stored and appended to easily using either the software itself or manual editing through SQL queries. Careful documentation will be made within the code itself as to ensure others in the field with expertise in coding could add to the software if they deem willing to do so. Features from other software will either be implemented right away or over time depending on usage and need for certain tools but designing the software in a way that allows for modularity will allow for easier implementation of entire new tools.

4. Outcomes

I hope that the program that is developed can be robust and more visually appealing than other limited options as well as being more user friendly for beginners going into the field. The biggest implication of having this program could be wide adoption of its usage making the entire environment of storing data better for the users so they can focus more on collecting data rather than figuring out how niche programs work.

5. References

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6. Figures

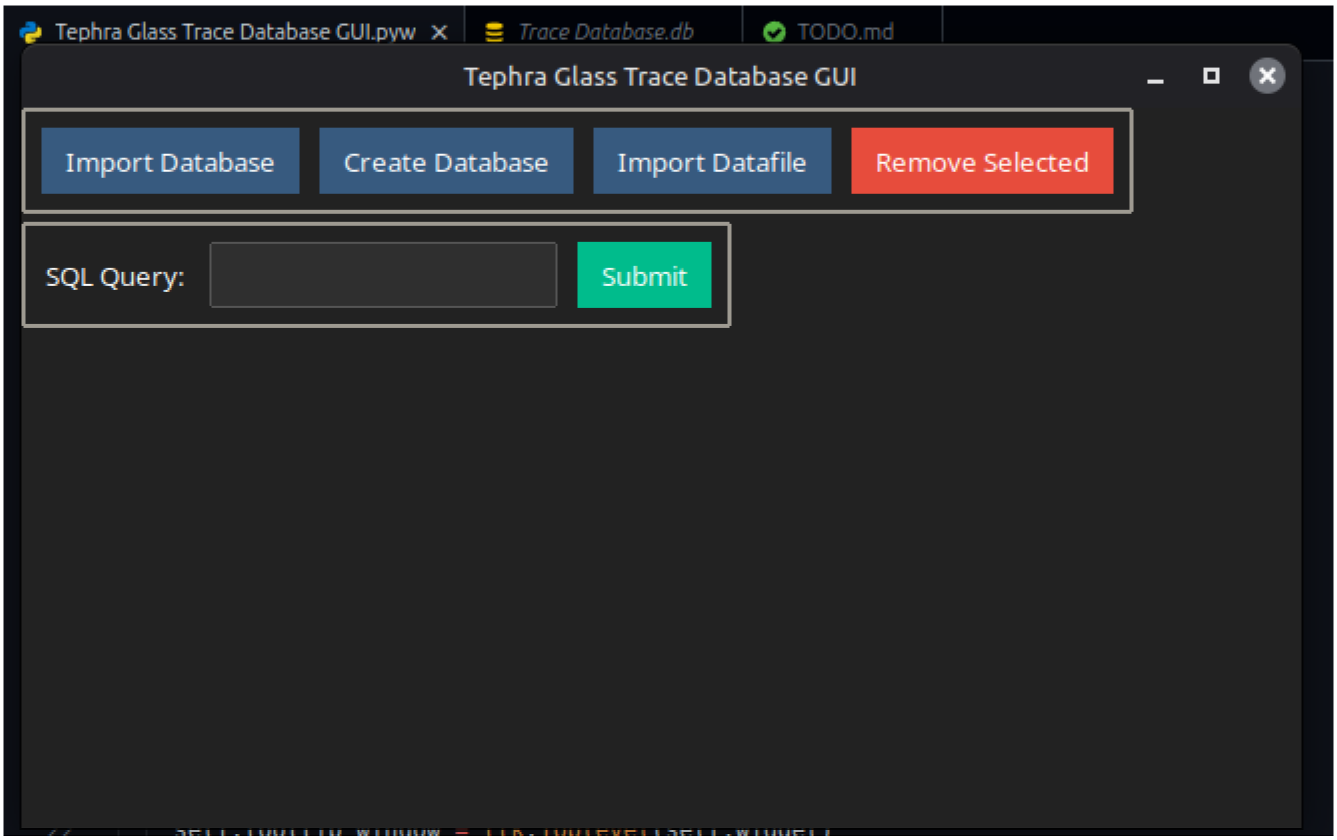
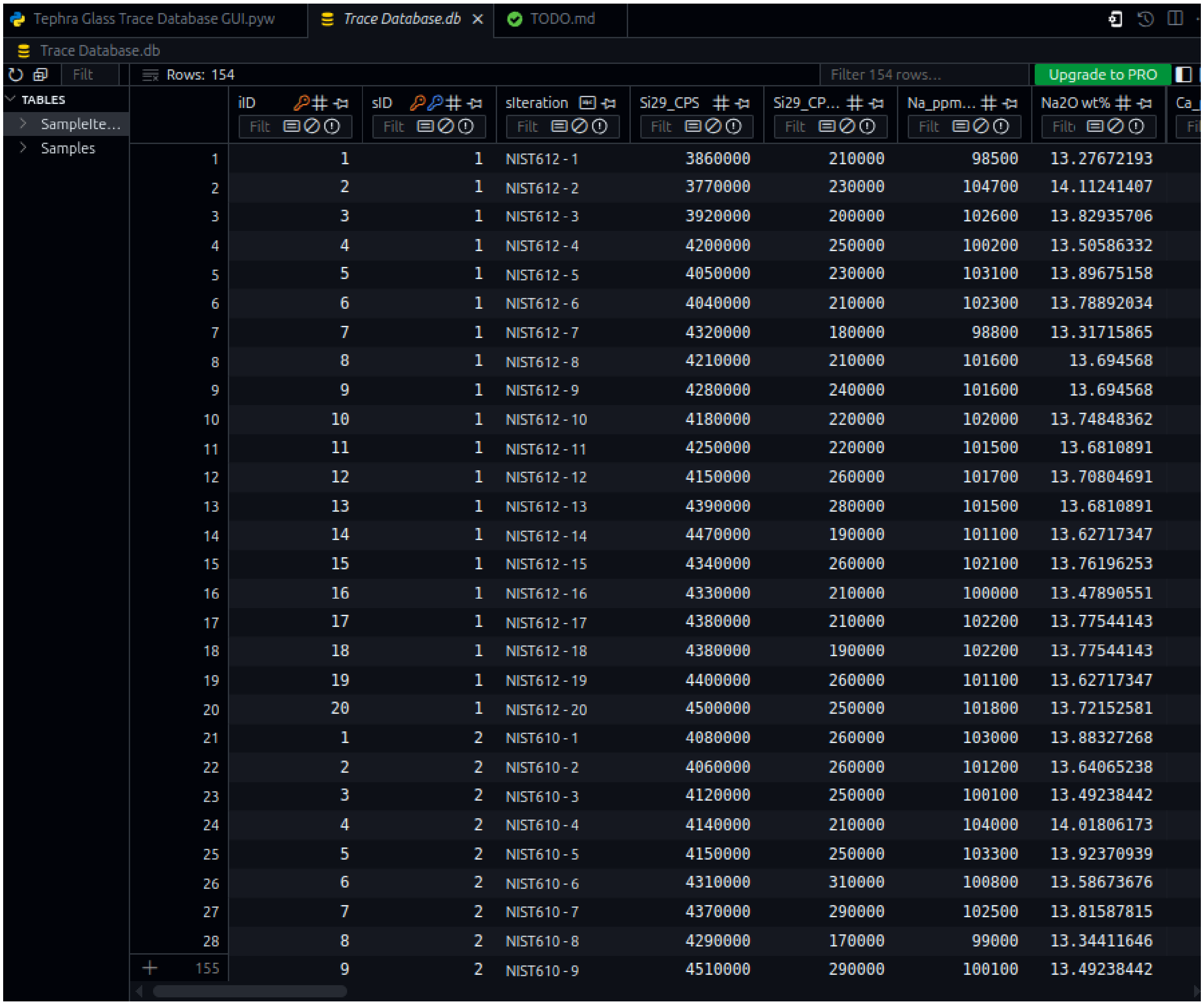


Figure 1. Early stages of software development



	iID	sID	sIteration	Si29_CPS	Si29_CP...	Na_ppm...	Na2O wt%
1	1	1	NIST612 - 1	3860000	210000	98500	13.27672193
2	2	1	NIST612 - 2	3770000	230000	104700	14.11241407
3	3	1	NIST612 - 3	3920000	200000	102600	13.82935706
4	4	1	NIST612 - 4	4200000	250000	100200	13.50586332
5	5	1	NIST612 - 5	4050000	230000	103100	13.89675158
6	6	1	NIST612 - 6	4040000	210000	102300	13.78892034
7	7	1	NIST612 - 7	4320000	180000	98800	13.31715865
8	8	1	NIST612 - 8	4210000	210000	101600	13.694568
9	9	1	NIST612 - 9	4280000	240000	101600	13.694568
10	10	1	NIST612 - 10	4180000	220000	102000	13.74848362
11	11	1	NIST612 - 11	4250000	220000	101500	13.6810891
12	12	1	NIST612 - 12	4150000	260000	101700	13.70804691
13	13	1	NIST612 - 13	4390000	280000	101500	13.6810891
14	14	1	NIST612 - 14	4470000	190000	101100	13.62717347
15	15	1	NIST612 - 15	4340000	260000	102100	13.76196253
16	16	1	NIST612 - 16	4330000	210000	100000	13.47890551
17	17	1	NIST612 - 17	4380000	210000	102200	13.77544143
18	18	1	NIST612 - 18	4380000	190000	102200	13.77544143
19	19	1	NIST612 - 19	4400000	260000	101100	13.62717347
20	20	1	NIST612 - 20	4500000	250000	101800	13.72152581
21	1	2	NIST610 - 1	4080000	260000	103000	13.88327268
22	2	2	NIST610 - 2	4060000	260000	101200	13.64065238
23	3	2	NIST610 - 3	4120000	250000	100100	13.49238442
24	4	2	NIST610 - 4	4140000	210000	104000	14.01806173
25	5	2	NIST610 - 5	4150000	250000	103300	13.92370939
26	6	2	NIST610 - 6	4310000	310000	100800	13.58673676
27	7	2	NIST610 - 7	4370000	290000	102500	13.81587815
28	8	2	NIST610 - 8	4290000	170000	99000	13.34411646
155	9	2	NIST610 - 9	4510000	290000	100100	13.49238442

Figure 2. Current design of backend database

```sql
CREATE TABLE "Samples" ("sID" INTEGER NOT NULL,
                        "sName" TEXT NOT NULL,
                        "IntStdWv" FLOAT,
                        PRIMARY KEY ("sID")
                        );

CREATE TABLE "SampleIterations" ("iID" INTEGER NOT NULL,
                                 "sID" INTEGER,
                                 "sIteration" TEXT,
                                 "Si29_CPS" INTEGER,
                                 "Si29_CPS_Int2SE" INTEGER,
                                 "Na_ppm_m23" INTEGER,
                                 "Na2O wt%" FLOAT,
                                 "Ca_ppm_m43" INTEGER,
                                 "Ca_m43_wt%" FLOAT,
                                 "Ca_ppm_m44" INTEGER,
                                 "Ca_m44_wt%" FLOAT,
                                 "Ti_ppm_m49" INTEGER,
                                 "Ti wt%" INTEGER,
                                 "Ga_ppm_m69" FLOAT,
                                 "Ga_ppm_m71" FLOAT,
                                 "Rb_ppm_m85" FLOAT,
                                 "Sr_ppm_m88" FLOAT,
                                 "Y_ppm_m89" FLOAT,
                                 "Zr_ppm_m90" FLOAT,
                                 "Zr_ppm_m91" FLOAT,
                                 "Nb_ppm_m93" FLOAT,
                                 "Cs_ppm_m133" FLOAT,
                                 "Ba_ppm_m137" FLOAT,
                                 "La_ppm_m139" FLOAT,
                                 "Ce_ppm_m140" FLOAT,
                                 "Pr_ppm_m141" FLOAT,
                                 "Nd_ppm_m146" FLOAT,
                                 "Sm_ppm_m147" FLOAT,
                                 "Eu_ppm_m153" FLOAT,
                                 "Gd_ppm_m157" FLOAT,
                                 "Tb_ppm_m159" FLOAT,
                                 "Dy_ppm_m163" FLOAT,
                                 "Ho_ppm_m165" FLOAT,
                                 "Er_ppm_m166" FLOAT,
                                 "Tm_ppm_m169" FLOAT,
                                 "Yb_ppm_m172" FLOAT,
                                 "Lu_ppm_m175" FLOAT,
                                 "Hf_ppm_m178" FLOAT,
                                 "Ta_ppm_m181" FLOAT,
                                 "Pb_ppm_m208" FLOAT,
                                 "Th_ppm_m232" FLOAT,
                                 "U_ppm_m238" FLOAT,
                                 PRIMARY KEY ("iID", "sID"),
                                 FOREIGN KEY ("sID") REFERENCES "Samples"("sID")
                                 );
```

Figure 3. Database SQL schema